Research Articles

*Validity and Reliability of the International Physical Activity Questionnaire in College Students

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ABSTRACT

The purpose of this study was to examine the validity and reliability of the self-administered International Physical Activity Questionnaire (IPAQ) short form in college students. One hundred twenty-three undergraduate students (20.8 ± 1.5 years of age, 76% Caucasian, 74% female) wore an accelerometer and pedometer at their waists for seven consecutive days and completed the IPAQ at the end of the week. Approximately 4–6 days later they completed the IPAQ again, recalling their physical activity during the week they wore the monitoring devices. Spearman correlation coefficients and intraclass correlation coefficients (ICC) were calculated to examine criterion validity and stability reliability respectively. Criterion validity correlation coefficients ranged from 0.15 to 0.26 for total weekly time spent in physical activity from the IPAQ and values from the accelerometer and pedometer. The ICCs between the two administrations of the IPAQ ranged from 0.71–0.89. The results of this study indicate that the validity indices of the questionnaire were similar to other self-report physical activity questionnaires and the stability reliability of the questionnaire was acceptable. Health education and promotion professionals can confidently use this questionnaire to assess college students' participation in physical activity.

Participation in physical activity declines significantly during adolescence and young adulthood.[1, 2] There is a steady decrease in physical activity from 9th to 12th grade and approximately 44% of high school students are either insufficiently physically active or inactive.[3] The trend continues among college students with more than 62% being insufficiently active.[4] This decline in physical activity is alarming because participation in regular physical activity is associated with numerous physical and emotional health benefits, as well as reduced risk of morbidity and all-cause mortality.[2] This reduction in physical activity and the lack of physical activity participation among college students indicates that this population should be targeted for intervention by health education and promotion professionals. Therefore, it is necessary to have valid and reliable instruments to assess physical activity in this population.

Questionnaires are commonly used to assess physical activity among college students because they are inexpensive, quick, and easy to administer.[5] The psychometric properties of two instruments, the *National College Health Risk Behavior Survey* physical activity items (*NCHRBS*) and the *7-Day Physical Activity Recall* (*7DPAR*) have been examined in college students.[6, 7]

The *NCHRBS* [4] is a self-administered instrument that requires participants to report their frequency of involvement in vigorous, moderate, stretching, and strengthening activities during the previous 7 days. The vigorous and moderate items specify minimum durations of 20 and 30 minutes, respectively. The *7DPAR* [8] determines the total time that an individual spends sleeping and being physically active. Specifically, time in moderate, hard, and very hard physical activity is recorded for the morning, afternoon, and evening of the previous seven days.[8] Although the *7DPAR* was originally designed to be interviewer-administered,[8, 9] a self-administered version has been successfully used with college students.[7] Both questionnaires were reported to have acceptable validity and reliability.[6,7]

Current physical activity recommendations state that individuals should partici-

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pate in at least 20 minutes of vigorous activity three days per week, or 30 minutes of moderate activity 5 days per week.[10, 11] Both of the recommendations stipulate that physical activity does not have to be performed in a single session, but can be accumulated throughout the day in bouts of at least 10 minutes. Furthermore, the results of several studies indicate that 10 minute bouts of physical activity accumulated throughout the day convey similar health benefits to longer bouts of activity.[12–14]

The *NCHRBS* does not inquire about physical activity that may have been performed in 10 minute bouts, while the *7DPAR* sums the total time in physical activity for each segment of the day, and thus may include activity performed for less than 10 minutes. To more accurately quantify physical activity participation that is beneficial to health, several questionnaires currently instruct participants to only report physical activities that were performed in bouts of at least 10 minutes.[15–18]

The *International Physical Activity Questionnaire* (*IPAQ*)[16] short form is a relatively new, self-administered instrument that requires participants to report only physical activities lasting at least 10 minutes. Participants record the frequency and duration of vigorous, moderate, and walking activities, as well as time spent sitting, during the last seven days. The validity and reliability of the *IPAQ* were examined among adults (age: 40.1 ± 7.6 years) living in several countries.[19] The criterion validity (pooled Spearman's ρ = 0.30, compared to an accelerometer) and test-retest reliability (pooled Spearman's ρ = 0.75) of the instrument were acceptable in this well-educated, middle-aged sample. Because the *IPAQ* is easy to administer and inquires about the four different domains of physical activity (transportation, occupation, house/lawn, and leisure) lasting at least 10 minutes, it may be a good questionnaire to assess physical activity among college students. Therefore, the purpose of this study was to examine the criterion validity and stability reliability of the *IPAQ* short form in college students.

METHODS

Participant Recruitment and Eligibility

Following approval by the institutional review board, undergraduate college students were recruited to participate in the study through announcements to large general education classes. Students were instructed to contact the researchers via email to determine eligibility and schedule an appointment to begin the study. Eligible participants were between 18–30 years of age, full-time undergraduate students, and responded "no" to all items on the Physical Activity Readiness Questionnaire (PAR-Q),[20] a screening instrument used to identify potentially dangerous health conditions that contraindicate physical activity. Researchers determined that 85 participants were needed for this study (power = 0.80, expected effect size 0.30, two-tailed α = 0.05).[21]

Study Design

Researchers utilized a descriptive, correlational research design. Participant responses to the questionnaire items were correlated with physical activity variables obtained from an accelerometer and pedometer.

Instruments

International Physical Activity Questionnaire. The self-administered short form of the *International Physical Activity Questionnaire* (*IPAQ*)[16] is a seven-item self-report instrument that assesses physical activity (lasting at least 10 minutes) across four different domains (transportation, occupation, house/lawn, and leisure) during the past seven days. Frequency and duration (minimum of 10 minute bouts) of vigorous activity, moderate activity, and walking are assessed. Participants also report the amount of time they spend sitting on a weekday, which is not included in the analysis of physical activity. Weekly time spent in vigorous activity, moderate activity, and walking is determined by multiplying reported frequency and duration within each category of activity. Total weekly time in physical activity is calculated by summing the three categories of activities listed above.

Accelerometers and pedometers are considered to be direct, quantitative measures of physical activity and they are often used to validate physical activity surveys.[5] Accelerometers and pedometers were used in this study as criterion measures of physical activity.

Accelerometer. The Manufacturing Technology Incorporated Actigraph Monitor Model 7164 [Actigraph (formerly CSA); Ft. Walton Beach, FL] is the accelerometer that was used in this study. The Actigraph is a single axis accelerometer that measures and records accelerations ranging in magnitude from 0.05 to 2 *g*. The Actigraph measures 2 x 1.6 x 0.6 inches and weighs 1.5 ounces.[22] The Actigraph is initialized and downloaded using a reader interface that is connected to a serial port of a computer. The validity of the Actigraph has been documented with counts (the summation of the acceleration signals) significantly correlated with energy expenditure and relative oxygen consumption during ambulatory activity.[23, 24] Additionally, the Actigraph has acceptable test-retest reliability (ICC = 0.80),[25] and when it is worn for seven consecutive days, physical activity can be assessed with 90% reliability.[26] When the Actigraph is worn at the waist, the number of steps taken can be determined.[22] The Actigraph does not provide the user with any feedback, and the Actigraphs used in this study were calibrated by the manufacturer prior to the start of this study.

Pedometer. The Accusplit Eagle 120 (San Jose, CA) was the pedometer used in this study. Distributed by Accusplit, this pedometer is identical to the Yamax Model 200,[27] which is among the most accurate pedometers available to assess steps.[27] When ambulatory movement results in a force ≥ 0.35 *g*,[27] the pedometer counts the number of steps an individual takes by vertically displacing a lever arm inside the unit that rotates a counting device to register steps.[28]

Procedures

Participants met with the researchers three times. During their first visit they completed the written informed consent, the PAR-Q,[20] and a short demographic questionnaire. They also had their height

and weight measured using a portable stadiometer and a physician's balance-beam scale. Each participant was fitted with an elastic belt that fit around his/her waist. The belts were used to attach the Actigraph (which was in a pouch) to the body, so that the Actigraph could be worn under clothing and fit snugly against the skin. Participants were instructed to keep the Actigraph in the pouch and to make sure that the pouch was oriented properly (velcro flap pointed downward and away from the body) when putting on the Actigraph each morning. Participants were told to wear the Actigraph monitor over their right iliac crest during all waking hours for the next seven consecutive days, except when showering, bathing, or swimming. Participants were instructed to remove the Actigraph when going to bed at night and to record what time they put on and removed the Actigraph each day onto their log sheet.

Participants also received a pedometer to wear in conjunction with the accelerometer. They were instructed to wear the pedometer over the midline of their right leg on the waistband of their clothing. They were told to record the number of steps taken each day onto their pedometer step log and to reset the pedometer each morning before wearing the device. Similar to the Actigraph, they were instructed to remove the pedometer when going to bed at night, bathing or swimming.

At the end of the week, participants met with the researchers a second time to return the Actigraph, pedometer, and log sheets. During this visit they completed the *IPAQ*, recalling their physical activity during the seven-day period that they wore the monitoring devices. Participants met with researchers a third time 4–6 days following their second visit. During this third visit, they completed the *IPAQ* again, recalling their participation in physical activity during the seven-day period that they wore the accelerometer and pedometer. To help the participants recall the appropriate timeframe they were shown a calendar, with the week the monitoring devices were worn highlighted. This design controls for the true variation in physical activity by removing this variation from the reliability estimation.[29]

Data were collected in three different cohorts, ranging in size from 47 to 52 participants, between January and March 2004. All participants who completed the study received a brief report that included information about their daily caloric expenditure in physical activity.

Data Reduction and Analysis

SAS version 8.1 (Cary, NC) was used for all data reduction and analysis. One-minute cycle periods were used in this study. Counts/minute were summed across each 60-minute period throughout the day to obtain total counts/hour for each day. The number of hours during each 24-hour period with total counts/hour greater than zero was determined. The accelerometer compliance requirements, decided upon *a priori* by the researchers, were that participants must have at least 12 hours/day with total counts/hour greater than zero (indicating that the accelerometer was actually worn ≥ 12 hours/day), on at least five of the seven days, in order to be included in the analyses. These requirements allowed for a minimum of 75% coverage for 16 waking hours on at least five of seven days of the week.

The Freedson et al.[23] cut-points (light <1952 counts/minute, moderate 1952–5724 counts/minute, hard 5725-9498 counts/minute, and very hard > 9498 counts/minute) were used. These cut-points were selected because the moderate intensity category was calibrated to walking, which is the most common type of ambulatory activity.[30] Furthermore, we combined the hard and very hard categories of Freedson et al. into a vigorous intensity category (≥ 5725 counts/minute; ≥ 6 METs). Because the current physical activity recommendations[10, 11] indicate that physical activity should be accumulated in bouts of at least 10 minutes, the data were examined to determine the number of minutes per day spent in moderate/vigorous physical activity (≥ 1952 ct/minute) that occurred in bouts of at least 10 minutes.

Steps/minute from the Actigraph were summed across 60 minutes to obtain total steps/hour for each day. The hourly step values were summed across all hours the accelerometer was worn to determine steps/day from the Actigraph (ACC Steps).

There were 154 participants who initially began the study. Three of the participants decided not to complete the study and returned their Actigraphs before the end of the first week. In addition, the researchers excluded data from four participants due to battery malfunction. This resulted in a sample of 147 participants. After applying the *a priori* data compliance requirements (≥ 12 hours/day on ≥ 5 days/week), 123 participants (80% of those recruited) remained in the final sample. The compliance rates were very high among the 123 participants meeting the data compliance criteria (i.e., 6.5 ± 0.7 days and 15.5 ± 1.1 hours/day of monitoring).

Descriptive statistics were calculated for the demographic and physical activity variables. Analysis of variance (ANOVA) was used to examine differences in total counts/day by cohort. There was not a significant difference in total counts/day (F [2, 120] = 1.83, p = 0.16) among the three cohorts; therefore, data from the three cohorts were combined for analyses.

Because the *IPAQ* data were not normally distributed, Spearman correlation coefficients were calculated to examine the relationship between students' responses to the *IPAQ* items and the physical activity variables. In addition, the consistency of students' responses to the *IPAQ* items at both administrations was compared by calculating intraclass correlation coefficients (ICC) using one-way ANOVA models[29] and paired t-tests. Twelve participants did not attend the third visit and failed to complete the *IPAQ* a second time. Therefore, ICCs were calculated using a sample of 111 participants.

RESULTS

Participant Demographics and Physical Activity

Characteristics of the 123 participants are presented in Table 1. They were 20.8 ± 1.5 years of age. The majority of participants were Caucasian (75.6%, n = 93), female

(74.0%, n = 91), and underclassmen (94.3%, n = 116). Demographic characteristics of males and females were similar; however, males were more racially diverse and had higher BMIs than females.

Overall, students reported being very physically active, engaging in 589.4 ± 404.9 minutes of total physical activity during the previous week. Males reported spending significantly more time than females in vigorous physical activity ($t = 3.2$, $df = 37.9$, $p = .003$).

Data from the accelerometer revealed that students accumulated 310,359.2 ± 120,884.9 counts/day and 35.0 ± 15.4 minutes/day in moderate physical activity. Males accumulated more minutes of moderate physical activity ($t = 3.1$, $df = 40$, $p = .004$) and pedometer steps/day (PED steps; $t = 2.1$, $df = 43.9$, $p = .04$) than females (Table 2). When participation in physical activity was examined in bouts of at least 10 minutes, the results changed considerably. Participants spent 11.1 ± 11.1 minutes/day (73.5 ± 74.2 minutes/week) in moderate/vigorous physical activity occurring in at least 10 minute bouts.

Validity

Time spent in vigorous physical activity from the *IPAQ* was significantly correlated with steps/day from the accelerometer (ACC Steps) and PED Steps, as well as all count variables (ρ: 0.30 – 0.47, $p < 0.01$). Time spent in moderate activity from the *IPAQ* was significantly associated with the majority of accelerometer variables (ρ: 0.19 – 0.23, $p < 0.05$), and time spent walking was not significantly correlated to any step or count variables (Table 3).

Reliability

Reported time spent in each category of physical activity was compared between the two administrations of the *IPAQ* to examine stability reliability of the instrument. The reported amount of time spent in moderate ($t = 3.9$, $df = 110$, $p < .01$) and total physical activity ($t = 2.5$, $df = 110$, $p = .01$) was different between administrations (Table 4). The intraclass correlation coefficients (ICC) ranged from 0.71 – 0.89, indicating moderate to high reliability of the questionnaire items.

Table 1. Descriptive Characteristics

	Males (n = 32)	Females (n = 91)
Age (yr): mean ± sd	20.8 ± 1.2	20.8 ± 1.6
BMI (kg/m^2): mean ± sd	27.1 ± 3.9*	22.6 ± 2.9
Race: count (%)		
Caucasian	20 (62.5)	73 (80.2)
Other	12 (37.5)*	18 (19.8)
Class in College: count (%)		
Underclassmen	30 (93.8)	86 (94.5)
Upperclassmen	2 (6.2)	5 (5.5)

Note. * $p < 0.05$

DISCUSSION

To our knowledge, this is the first study to examine the psychometric properties of the self-administered *IPAQ* short-form in college students. The results of this study indicate that the validity indices of the questionnaire were similar to other self-report physical activity questionnaires and the stability reliability of the questionnaire was acceptable.

Few studies have been conducted to examine the validity of physical activity questionnaires in college students using direct measures of physical activity (i.e., measures that reflect actual body movement) such as accelerometers or pedometers as the criterion. Dinger[6] explored the validity of the *NCHRBS* physical activity items using accelerometers and pedometers as criterion measures. She reported correlation coefficients ranging from 0.03 to 0.61 for the *NCHRBS* vigorous and moderate activity items. In this study, time spent in vigorous and moderate physical activity from the *IPAQ* was correlated with several variables obtained from an accelerometer and pedometer. Correlations ranged from 0.14 to 0.47 for the vigorous and moderate sections of the *IPAQ*.

Sallis and Saelens[31] reviewed seven physical activity questionnaires that have been validated in young to middle-aged adults using an accelerometer as the criterion measure. They reported criterion validity correlations ranging from 0.14 to 0.53 for total questionnaire scores. In this study, total weekly time spent in physical activity was correlated with values from an accelerometer and pedometer, with correlation coefficients ranging from 0.15 to 0.26 (mean = 0.21). Although these values are at the lower end of the range of those reported in the review, they are similar to the correlations reported for the Minnesota Leisure-time Physical Activity Questionnaire (r = 0.21),[32] Paffenbarger Physical Activity Questionnaire (r = 0.30),[33] CARDIA Physical Activity History (r = 0.14),[34] and Baecke Questionnaire of Habitual Physical Activity (r = 0.23).[35]

In addition to examining the criterion validity of weekly total time spent in physical activity, we also calculated the criterion validity of time spent in vigorous, moderate, and walking activities from the *IPAQ*. The criterion validity correlation coefficients were higher for time spent in vigorous physical activity (mean = 0.41) and substantially lower for moderate physical activity (mean = 0.19), which is consistent with the literature. After reviewing the psychometric properties of seven physical activity questionnaires in their review, Sallis and Saleans[31] concluded that validity coefficients are higher for reports of vigorous physical activity and lower for reports of moderate activity. Basically, individuals recall their participation in vigorous physical activity (exercise) more accurately than they can recall time spent in moderate activities, such as working around the house and/or yard.

Table 2. Physical Activity of the Sample

Measure	Females (n = 91)	Males (n = 32)	Total (n=123)
IPAQ			
Vigorous (minutes/week)	94.8 ± 106.0	209.4 ± 192.1**	124.6 ± 142.2
Moderate (minutes/week)	98.7 ± 109.4	136.1 ± 141.3	108.5 ± 119.1
Walking (minutes/week)	347.6 ± 305.5	381.1 ± 329.1	356.3 ± 310.8
Total (minutes/week)	541.1 ± 350.8	726.6 ± 511.6	589.4 ± 404.9
Accelerometer			
Total Counts (counts/day)	295,459.0 ± 105,238.2	325,731.7 ± 151,166.7	310,359.2 ± 120,884.9
Vigorous (minutes/day ≥ 5725 counts)	5.5 ± 7.5	6.2 ± 9.0	5.7 ± 7.9
Moderate (minutes/day 1952-5724 counts)	32.0 ± 12.4	43.4 ± 19.7**	35.0 ± 15.4
Moderate/vigorous[a] (minutes/day ≥ 1952 counts)	10.4 ± 9.3	13.0 ± 15.3	11.1 ± 11.1
Moderate/vigorous[a] (minutes/week ≥ 1952 counts)	68.6 ± 63.0	87.5 ± 99.2	73.5 ± 74.2
ACC Steps (steps/day)	9,654.3 ± 2,556.1	10,851.2 ± 3,562.2	9,965.7 ± 2,884.8
Pedometer			
PED Steps (steps/day)	7,894.3 ± 2,757.0	9,374.9 ± 3,671.0*	8,279.5 ± 3,075.2

Notes. Values are mean ± sd, [a]Bouts ≥ 10 minutes duration, *$p < 0.05$, **$p < 0.01$

Table 3. Spearman Correlation Coefficients and 95% Confidence Intervals (CI) between *IPAQ* Variables and Objective Physical Activity Measures

Measure	Vigorous ρ (95% CI)	Moderate ρ (95% CI)	Walking ρ (95% CI)	Total ρ (95% CI)
Accelerometer				
Total Counts (counts/day)	0.47** (0.32, 0.61)	0.21* (0.03, 0.39)	0.07 (-0.10, 0.25)	0.23** (0.06, 0.40)
Vigorous (minutes/day ≥ 5725 counts)	0.47** (0.32, 0.62)	0.19* (0.01, 0.36)	0.02 (-0.16, 0.19)	0.15 (-0.02, 0.32)
Moderate (minutes/day 1952-5724 counts)	0.39** (0.24, 0.55)	0.23* (0.05, 0.41)	0.10 (-0.09, 0.28)	0.26** (0.09, 0.43)
Moderate/vigorous[a] (minutes/day ≥ 1952 counts)	0.44** (0.28, 0.60)	0.19* (0.02, 0.37)	0.08 (-0.09, 0.25)	0.20* (0.03, 0.37)
Moderate/vigorous[a] (minutes/week ≥ 1952 counts)	0.45** (0.29, 0.61)	0.20* (0.03, 0.38)	0.10 (-0.07, 0.27)	0.22* (0.05, 0.39)
ACC Steps (steps/day)	0.30** (0.13, 0.47)	0.14 (-0.03, 0.32)	0.05 (-0.13, 0.23)	0.17 (-0.01, 0.35)
Pedometer				
PED Steps (steps/day)	0.38** (0.22, 0.53)	0.17 (-0.01, 0.35)	0.12 (-0.06, 0.29)	0.25** (0.08, 0.42)

Notes. [a]Bouts ≥ 10 minutes duration, *$p < 0.05$, **$p < 0.01$

Table 4. Reliability of IPAQ (n = 111)				
	Administration One[a]	Administration Two[a]	ICC	95% CI
Vigorous (minutes/week)	115.5 ± 138.7	118.4 ± 126.8	0.89	0.84, 0.93
Moderate (minutes/week)	107.3 ± 119.4	155.5 ± 164.7**	0.71	0.58, 0.80
Walking (minutes/week)	348.4 ± 312.8	367.4 ± 307.2	0.89	0.84, 0.93
Total (minutes/week)	571.1 ± 408.8	641.4 ± 453.0**	0.86	0.80, 0.91

Notes. [a]values are mean ± sd, *$p < 0.05$, **$p < 0.01$ between administrations

The correlations between time spent walking and measures from the accelerometer and pedometer were very low (mean = 0.08). One possible explanation for this finding is that the *IPAQ* inquires separately about moderate physical activity and walking activities. Participants are instructed to record the number of days they spent doing moderate activities for at least 10 minutes at a time. At the very end of the instructions for the moderate activity questions there is this statement: "Do not include walking." Although there are questions pertaining to walking that follow on the questionnaire, it is plausible that participants include the time they spend walking under the moderate category and under-report time on the walking questions. Health education researchers and practitioners who use this questionnaire should instruct participants that time spent walking should only be reported in the walking section of the questionnaire and not included in the moderate physical activity category. Furthermore, participants must be reminded to only report physical activities that lasted at least 10 minutes.

During the development of the *IPAQ*, Craig et al.[19] examined the test-retest reliability of the *IPAQ* short form in 292 adults living in three different countries. Participants in their study completed the *IPAQ* on two different occasions, not more than 8 days apart. They reported acceptable test-retest reliability of the instrument (pooled Spearman's $\rho = 0.75$). In this study we examined the reliability of the *IPAQ* short form using the design recommended by Patterson.[29] Because participation in physical activity fluctuates from week to week, participants recalled their physical activity for the same reference week (the week they wore the accelerometer and pedometer) at both administrations of the questionnaire. This design controls for the weekly variability in physical activity and allows for a more accurate assessment of instrument reliability. In addition, we used one-way ANOVA models to calculate ICCs.[29] Although our design and calculations varied from those employed by Craig et al.,[19] our findings were similar. The reliability coefficients in this study were moderate to high, ranging from 0.71–.89. This indicates that the *IPAQ* short form exhibited acceptable reliability.

This study has limitations. First, although accelerometers and pedometers are direct measures of physical activity and commonly used to examine the criterion validity of questionnaires,[5,31] they only capture ambulatory physical activity. Although walking is the most common physical activity,[30] it is possible that participants in this study may have engaged in bicycling or upper body movements that were not assessed by the accelerometer and pedometer. Second, all participants were volunteers and therefore may not be representative of the larger college student population. Third, the majority of participants were female and Caucasian. The results may differ in more diverse samples.

Health education and promotion professionals must develop interventions to address the steady decline in physical activity among college students. It is imperative that valid and reliable instruments be used to assess physical activity in this population as a part of the needs assessment and/or intervention evaluation process. The results of this study indicate that the self-administered *IPAQ* short-form has acceptable stability reliability and criterion validity indices similar to other self-report physical activity questionnaires. Therefore, health education and promotion professionals can confidently use this questionnaire to assess college students' participation in physical activity.

ACKNOWLEDGEMENTS

The authors thank Scott Hawkins, M.S., Mandy Qualls, M.S., and Kristi McClary, M.S. for assisting with data collection. This study was completed while the second author was a doctoral student in the Department of Health and Exercise Science at the University of Oklahoma.

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